cable to the existing case without any manner of doubt. The mystery of the great ice age, and of the former rich vegetation in the present cold zone, still remains to be solved.

FRANK WALDO.

An Outline of the Theory of Solutions, and Its Results, for Chemists and Electricians. By J. LIVINGSTON R. MORGAN, PH.D. (Leipzig), Instructor in Quantitative Analysis, Polytechnic Institute, Brooklyn. New York, John Wiley & Sons; London, Chapman & Hall. 1897. Pp. 63.

The contents of this work are four lectures, delivered before the Brooklyn Institute of Arts and Sciences, and deal with the theory of solutions, methods for the determination of electrolytic dissociation, the theory of the voltaic cell, and analytical chemistry from the standpoint of electrolytic disociation.

The author states in his preface that "a knowledge of the theory of solution and its results, is so important to workers in all branches of chemistry and electricity, that the following pages have been compiled, containing an elementary treatment of the subject." * * * "If by this sketch the author can induce any one to go deeper into the subject he will feel more than repaid for his work."

H. C. J.

Untersuchungen über das Erfrieren der Pflanzen. MOLISCH. Jena, Gustav Fischer. 1897. Pp. viii + 73. 11 illustrations.

A notable addition to the physiology of the cell has been recently published by Professor Molisch as a result of several years' work upon the effect of cold upon plants.

The researches upon which generalizations rest are fragmentary and necessarily inaccurate, since they were carried on in the open air or under conditions of great discomfort to the observer. At the same time no regulation of the temperature could be effected. Dr. Molisch has been enabled to obtain results of great importance, both from the advance in cell physics since the time of Muller's experiments and by the use of ingeniously constructed apparatus.

Dr. Molisch's researches were chiefly conducted by means of a double-walled freezing chamber of wood 33 x 33 x 27 cm. outside measurements. The space of 7 cm. between the double walls on five sides of the chamber was filled with sawdust. The center of the chamber was occupied by a zinc compartment to contain a microscope. A tubulated opening through the walls of the zinc and wooden compartments allowed access of light to the mirror, and toothed rods for adjustment of the stage, objectives and mirror extended outside the walls. The space surrounding the zinc compartment was filled with a mixture of salt and ice, by which temperatures of 4°C. to 10°C. were obtained in a room kept at 10°C.

As a useful preliminary, observations were made upon the freezing of colloidal substances, emulsions, color and salt solutions. The crystals were seen to appear suddenly in a colloid, such as gelatine, and to increase in size, extracting the water from the gelatine, so that the latter shrunk into a network resembling parenchyma tissue. Some colloids return to the original condition upon thawing; others do not. Starch paste is an example of the latter. The suspended particles in an emulsion, such as latex, aggregate in the form of a network of bands upon freezing. Freezing of color and salt solutions result in the more or less complete separation of the solid and solvent.

The chief interest of the paper lies in the results of the direct and continuous observation of the freezing of living cells.

An amœba, after exposure of 25 minutes to a temperature of 9°C., exhibited the formation of clumps of ice crystals in the plasma, and finally became a solid lump consisting of a complicated network of plasma almost devoid of water, ice crystals, vacuoles of concentrated cell-sap and air-bubbles. The slender filaments of Phycomyces froze only when the temperature fell to —17° C. The small diameter of the cells seem to be a direct adaptation against freezing. Yeast cells exhibited a shrinkage of 10 per cent., due to loss of water when the medium was frozen, but the cells were not killed at –15°C. The freezing of Spirogyra filaments at –3 to –6°C. is accompanied by a shrinkage in diameter amounting to 62 per cent. and by the final aggregation of chlorophyll band and nucleus in the center of the cells. The excretion of water in this plant under low temperatures may be easily observed

if a specimen is mounted in olive oil. The excretion of water from the cells soon begins and a cylinder of ice is formed about the filament.

As a result of the work upon unicellular structures in many organisms, it is found that the freezing may be accompanied by the formation of ice in the cell, external to the cell membrane or in both places. In either case it is accompanied by a more or less complete separation of the water from the plasma. The exposure of tissues with strongly developed walls to low temperatures was accompanied by the excretion of ice into the intercellular spaces, followed by the formation of ice both here and in the cell. Not all the cells of a plant exhibit the same resistance to cold. A temperature of a few degrees below zero Centigrade may freeze a leaf while the guard cells and hairs will remain intact. These cells are likewise highly resistant to heat and other agencies, as Leitgeb has previously demonstrated.

The question as to the death of a plant upon freezing or consequent thawing has engaged the attention of a large number of workers. Molisch's results prove that generally the death of a plant is due to the direct action of cold upon the plasma, and that the consequent thawing does not matter whether slow or rapid, in air or water. To this generalization an exception is offered by the experience of Müller-Thurgau, who found that frozen fruits of the apple and pear were not destroyed if thawed slowly, a fact long known in household practice, and the experiment of Molisch with *Agave americana*, which behaved in a similar manner. These exceptions, of course, rest upon the provision that the temperature has not fallen below a certain limit.

The death of plants from temperatures above the freezing point may result from disturbances of the metabolic processes or the transpiratory activity. In the latter instance the 'frosting' of a plant is due to the decreased osmotic activity of the root hairs under low temperatures, and wilting of the leaves consequent upon an insufficient supply of water. Dr. Molisch is mistaken in attributing the origin of this idea to Krabbe, as the principle has been known for many years, although its detailed application was first exploited by Krabbe.

Among the plants which are killed by low temperatures above freezing point, the most delicately responsive are *Episcia discolor* Hook., *Sanchezia nobilis* Hook., *Eranthemum tricolor* Nichols., *E. couperi* Hook., *E. igneum* Linden., *Anœctochilus setaceous* Blume. The species in this list exhibit damage after exposure to temperatures 1.4° C. to 3.7° C. for periods of 18 to 100 hours. *Begonia stigmatosa*, *B. scandens*, *Bœhmeria argentea* Linden, *Tradescantia discolor*, *T. zebrina*, and *Euphorbia splendens*, *Ficus elastica*, *Gloxinia hybrida*, *Tropæolum majus*, are examples of a numerous class which are injured by longer exposure to the same temperature. It is to be seen that Molisch's carefully attained results sustain the contention of Goeppert and Müller-Thurgau that death from freezing is due to the formation of ice or to the direct influence of cold, and not to the processes of thawing as maintained by Sachs. The formation of ice entails the excretion of water from the protoplasm, and the great and rapid loss of the fluid results in the architectural disintegration of the plasma. The disintegration may be hastened by the poisonous action of concentrated cell-sap remaining.

So far as the results are at hand, it is to be said that the excretion of water by cells at low temperatures is not only a physical reaction, but this action has become under the direction of the protoplasm a protective adaptation. A second adaptation consists in the smallness of the cell.

D. T. MACDOUGALL.

SOCIETIES AND ACADEMIES.

BOSTON SOCIETY OF NATURAL HISTORY.

THE Society met December 1st; thirty-five persons present. Professor N. S. Shaler, in discussing Aeolian deposits in relation to the formation of river valleys, gave the result of his observations in Utah and Montana. Along the Ruby river, where the vegetation is dense and the soil rich, the loess is held and the valley built up. In Montana below 7,000 feet the vegetation is thin and insufficient to inhibit.

Mr. A. W. Grabau showed some fossils from the upper Devonian of western New York, and gave the views taken by various investigators as to the nature of Conodonts, since their discovery by Pander in the Silurian and Devonian